Rover-Based Non-Prehensile Manipulation for Improved Mobility, Scientific Exploration, and Terrain Shaping on Planetary Surfaces, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

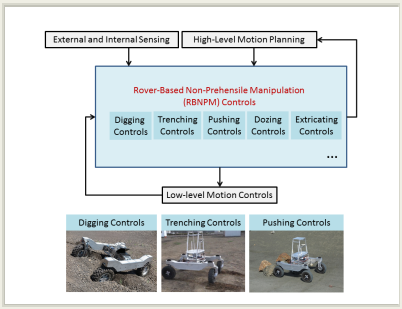
ProtoInnovations, LLC (PI) will research, design, develop, and validate advanced locomotion controls, rover-based non-prehensile manipulation (RNM) actions, and novel hardware/software architectures to allow rovers to alter the environment around them for the purposes of improving terrainability, aiding in scientific investigations, and accomplishing construction tasks. This work will require the development of analytical models for different rover configurations and different terrains. These models will give insight into the RNM capabilities of current NASA rover configurations, design considerations for future NASA rover configurations, and requirements for controllable RNM actions. Useful RNM actions will also be explored by considering the impact on NASA missions as well as their feasibility on current NASA rovers. Control strategies will then stem from analytical model research and RNM action definitions. Locomotion controls verification and validation will be done in simulation and on real NASA rovers in the field.

Phase I will involve the research and development of the analytical models that inform RNM actions, control architecture conceptualization, and the implementation of a set of RNM actions both in simulation and on at least one NASA rover. Meeting these objectives will form deliverables that directly benefit NASA as well as mark significant progress in the overall project objective of enabling RNM actions for improved mobility, better scientific investigations, and new rover functions.

Anticipated Benefits

The proposed robotic innovations will aid NASA will enable new concepts for missions to the Moon and Mars. Actions such as pushing rocks or moving loose soil into precarious ditches to create new navigable terrain will aid extreme-terrain mobility. Additionally, robotic excavation objectives will be simplified from controlled rover-based non-prehensile actions. This project will also provide a new perspectives on mobility/manipulator components and mobile manipulation architectures.

A large number of applications in mining, construction, farming, infrastructure, and utility industries call for robust, reliable, and innovative solutions to automation of work activities. Where the cost of additional complexity is prohibitive, rover-based non-prehensile manipulation promises to be the next standard, integrated by Original Equipment Manufacturers into a variety of vehicles and machinery.



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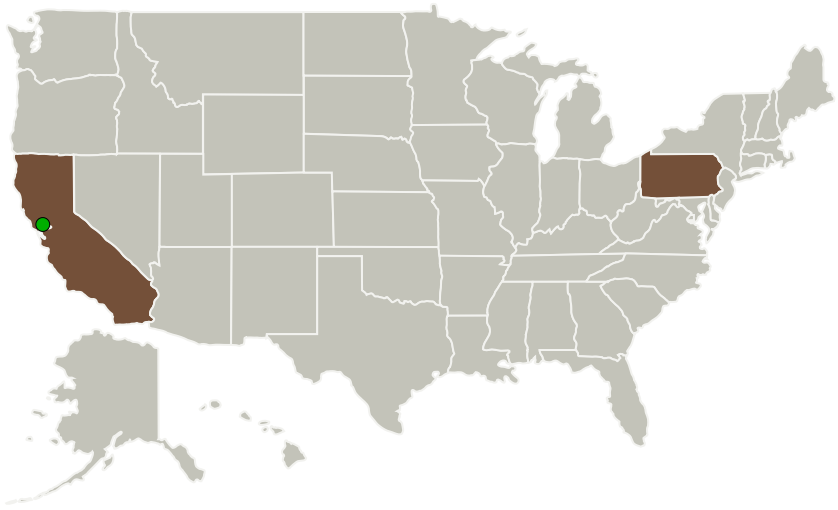
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Protoinnovations, LLC	Lead Organization	Industry	Pittsburgh, Pennsylvania
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141278)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Protoinnovations, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

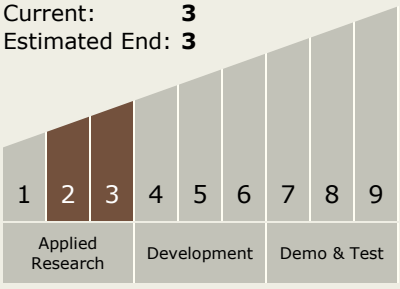
Carlos Torrez

Principal Investigator:

Dimitrios Apostolopoulos

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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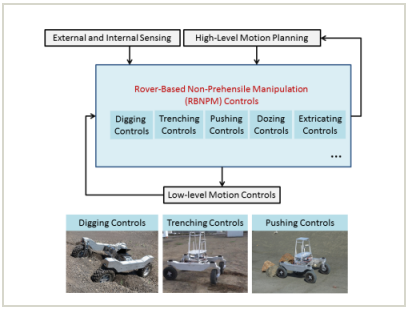
Images



Briefing Chart Image
Rover-Based Non-Prehensile Manipulation for Improved Mobility, Scientific Exploration, and Terrain Shaping on Planetary Surfaces, Phase I
(https://techport.nasa.gov/image/127118)

Final Summary Chart Image
Rover-Based Non-Prehensile Manipulation for Improved Mobility, Scientific Exploration, and Terrain Shaping on Planetary Surfaces, Phase I
(https://techport.nasa.gov/image/131658)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility

Target Destinations

The Moon, Mars, Others Inside the Solar System